2018-00765 - Localisation of zeros of quasi-polynomials in the complex plane - Application to the stability analysis of Delay Systems

Level of qualifications required : Graduate degree or equivalent
Fonction : PhD Position

About the research centre or Inria department

Located at the heart of the main national research and higher education cluster, member of the Université Paris Saclay, a major actor in the French investments for the Future Programme (Idex, LabEx, IRT, Equipex) and partner of the main establishments present on the plateau, the centre is particularly active in three major areas: data and knowledge; safety, security and reliability; modelling, simulation and optimisation (with priority given to energy).

The 450 researchers and engineers from Inria and its partners who work in the research centre's 31 teams, the 100 research support staff members, the high-level equipment at their disposal (image walls, high-performance computing clusters, sensor networks), and the privileged relationships with prestigious industrial partners, all make Inria Saclay Île-de-France a key research centre in the local landscape and one that is oriented towards Europe and the world.

Context

Delays are strongly involved in challenging areas of communication and information technologies. From a mathematical point of view, the presence of delays makes it difficult to characterize the stability of dynamical systems. When working in the frequency domain and analyzing the transfer function of such dynamical systems, we are faced to the problem of locating the poles of the transfer function in the complex plane: they are zeros of quasi-polynomials and indeed in infinite number. Since stability requires having no poles in the closed right half-plane, a question of prime interest is the presence of absence of poles in the closed right half-plane.

The seminal work of Bellman&Cooke 1 allowed to define two classes of systems: the class of retarded delay systems which have a finite number of poles in the closed right half-plane and the class of neutral systems which may have an infinite number of poles in the closed right half-plane (distributed as chains of poles asymptotic to vertical lines in the complex plane together with poles of small modulus) and are much more difficult to analyze. Recently, we got a precise characterization of the asymptotic poles of neutral systems with commensurate delays (see \( \alpha \) and \( \beta \)) but the theoretical or numerical characterization of the position of their poles of small modulus in the complex plane of poles is still a challenge.

References:


Assignment

The aim of this PhD is to progress on the effective characterization of the presence of poles in the closed right half-plane (and stability) for several classes of systems:

- for neutral type systems with commensurate delays, where the remaining question is essentially the position of poles of small modulus.
- for neutral type systems with non commensurate delays for which not much is known and a complete study should be performed.

Conditions for application

Defence Security:
This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST). Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy:
As part of its diversity policy, all Inria positions are accessible to people with disabilities.

Warning: you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.
Some other questions such as the characterization of rightmost roots (in particular by giving conditions ensuring that they are real or complex) will be considered.

Main activities

Skills
We are looking for mathematicians and engineers with a strong background in mathematics (complex analysis, functional analysis) and an interest in analysis of dynamical systems.

Skills in Matlab and Maple will be appreciated.

Benefits package
- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Flexible working hours
- Sports facilities

Remuneration
1.982 euros brut/month for 2 first year, then 2.085 euros brut/month for the 3rd year